

# Course Outline

## 1. Document Information

<b>Degree Program</b>	Computer Science
<b>Course Number</b>	CS 431
<b>Course Title</b>	Cyber-Physical Systems
<b>Semester Hours</b>	3
<b>Course Coordinator</b>	Henry Hexmoor
<b>Revision Term</b>	Spring 2020
<b>Latest Revision</b>	Fall 2020

## 2. Catalog Description

The goal of this course is to introduce and develop an understanding of the computing and communication for Internet of Things as a subset of Cyber-Physical systems. Connectivity among devices in our daily lives such as WiFi-enabled thermostats, smart grids, and driverless cars is ushering in an era of sociality that transcends human social networks to machine to machine networks.

## 3. Textbooks

- Alur, R. (2015). Principles of Cyber-Physical Systems. MIT Press.

## 4. References

- Lee, E. & Sanjit A. (2016). Introduction to Embedded Systems: A Cyber-Physical Systems Approach. MIT Press.
- Tabuada, P. (2009). Verification and Control of Hybrid Systems: A Symbolic Approach, Springer-Verlag.

## 5. Course Learning Outcomes

- Learn the fundamentals of mathematical modeling of CPS
- Familiarize with the spectrum of analysis, testing and verification methods for CPS
- Gain basic understanding of algorithms for automatic synthesis and control of CPS
- Familiarize with modeling and simulation tools utilized in both research and industry

## 6. Assessment of the Contribution to Student Outcomes

Outcome	1	2	3	4	5	6	7
Assessed	X	X	X	X	X	X	X

## 7. Prerequisites by Topic

CS 306 with a grade of C or better or graduate standing.

## 8. Major Topics Covered in the Course

1. Modeling (15 lectures):
  - Discrete State Models
  - Discrete State Models with Simulink/Stateflow
  - Hierarchical State Machines
  - Continuous System Modeling
  - Timed Automata
  - Hybrid Automata
2. IoT (5 lectures):
  - Network Protocols
  - Wireless Sensor Networks
  - Mobile Networking
3. Analysis (10 lectures):
  - Safety Properties for CPS
  - State-Space Exploration
  - Symbolic Verification Methods
  - Analysis of Properties of Continuous Systems
  - Reachability Analysis for Hybrid Automata
  - Temporal Logics for Verification of CPS

4. Synthesis and Control (10 lectures):

Temporal Logic Parameter Mining and Synthesis

Temporal Logic Synthesis

Model Predictive Control

NOTE: When course is taken as 500-level credit (CS 591 “Special Topics”), there will be additional requirements such as a research project.